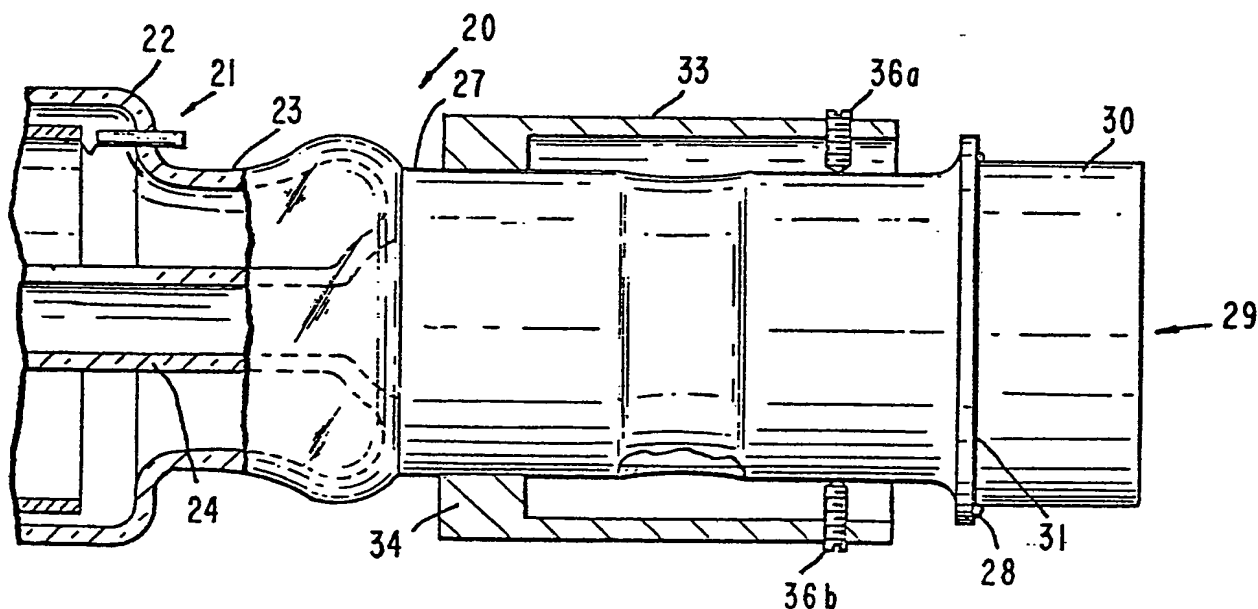




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: ADJUSTABLE MIRROR MOUNT FOR A LASER



## (57) Abstract

A mirror mount assembly which is attached to a laser tube and permits the adjustment of the mirror relative to the axis of the tube. It has an inner cylindrical member (27) one end of which is sealed to a laser tube (21) and a mirror (29) mounted to the other end. The midsection circumference of this cylinder may be made thinner so that it can be easily deflected about its axis. There is also an outer cylindrical member (33) which is coaxial to and surrounds the inner cylindrical member and a plurality of adjustment screws (36a-36d) which are radially disposed at the end of the outer member for deflecting the inner cylindrical member and the mirror.

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## ADJUSTABLE MIRROR MOUNT FOR A LASER

TECHNICAL FIELD

The invention relates generally to gas lasers and in particular relates to an improved adjustable mirror assembly for a laser.

BACKGROUND ART

Lasers have highly reflective mirrors located at either end of a lasing medium for stimulating light emissions and reflecting those emissions between them. Various schemes have been devised to permit alignment of these reflective mirrors relative to the axis of the laser plasma tube. Initially, the mirrors were mounted outside the evacuated plasma tube, which was usually terminated with Brewster windows, and placed in separate housings which were mechanically referenced or aligned to the laser plasma tube.

Gas lasers are generally constructed by two techniques; the first technique utilizes a plasma tube bottle in which windows (usually Brewster angle windows) are attached to the vacuum envelope and in which the regenerative cavity mirrors are supported externally to the bottle. It is a relatively uncomplicated matter to align and adjust the externally mounted mirrors. If the mirrors are properly aligned, the laser will function, and function well. If not, however, either the laser will not function at all or function only minimally.

It is desirable to have a mirror assembly which is an integral part of the laser plasma tube, not just an



1     appendage as some prior art lasers, in order to provide  
a more compact package. Also, an integrated plasma tube  
and mirror combination provides a more stable arrangement.

5     In the second technique, generally referred to as  
the "internal mirror" method, laser mirrors are attached  
directly to cylindrical metal housings at either end of  
the plasma tube which, in turn, are sealed to the vacuum  
bottle. The mirrors at either end complete the vacuum  
envelope. Each mirror is usually deposited on a cylin-  
10    drical glass substrate which is sealed in place with a  
glass frit or glass solder by placing the entire laser  
tube assembly in a 450°C oven.

More and more the laser industry is turning to the  
internal mirror technique even though such a technique  
15    poses certain problems. In order to hard seal the mirrors  
into place, they must be either pre-aligned to the bore  
of the resonant or laser cavity before sealing or must be  
aligned after sealing, i.e., while the laser is in oper-  
ation. Pre and post sealing alignment has been a difficult  
20    proposition.

One of the leading devices for adjusting a laser  
internal mirror is the well-known mirror mount fitting  
according to U.S. Patent No. 3,826,998. The mirror mount  
fitting includes a metal member having a weakened wall  
25    corrugation formed circumferentially therearound with a  
window closing the outer end of the fitting. The inner  
end of the fitting is made integral with the end of the  
laser tube and the reflecting mirror is formed on the  
closing window itself. The corrugation or single bellows-  
30    type formation on the fitting may extend inwardly or  
outwardly of the tube axis and is substantially weaker  
and of substantially lesser thickness than the remainder  
of the fitting wall. The fitting may be deformed at the  
corrugation such that the yield point of the material is  
35    exceeded to a sufficient extent to adjust the mirror to a  
desired position relative to the tube axis. There are



1 several limitations of such a device. A drawback of this  
prior art device is that the corrugation must be deformed  
beyond the elastic limit of the material so that the  
mirror will be set in place and not moved. Another  
5 undesirable feature is that the plastically deformed  
cylinder must be shielded from being bumped or jarred  
because the deformed area is weak and the cylinder may  
easily be deflected if bumped.

Another prior art device is a mirror holder assembly  
10 composed of two cylindrical members which are axially  
assembled together to form a gas tight seal at the joint.  
One end of the mirror holder assembly is attached to the  
plasma discharge tube while a mirror is mounted to the  
other end. Each of the cylindrical members has a flange  
15 which is perpendicular to the axis of the cylinders and  
the two flanges are separated by 2.54 mm (.10 inch) from  
each other. Screws extend through one of the flanges and  
press against the other flange. To adjust the mirror, the  
leverage of the screws is used to tilt the endmost  
20 cylinder thereby adjusting the alignment of the mirror.  
Such a device, although providing highly accurate and  
precise mirror adjustments, is costly to machine.

#### DISCLOSURE OF INVENTION

25 In accordance with the present invention, an adjust-  
able mirror mount for a laser is provided which has an  
inner cylindrical member with one end attached to a  
laser tube and the other having a mirror mounted thereon.  
An outer member surrounds the inner cylindrical member  
30 and is annularly separated therefrom. A plurality of  
radially disposed lever means extend through the outer  
member and impinge upon the inner cylindrical member  
for deflecting said inner member thereby adjusting  
the mirror.

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DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a partial cross-sectional view of an adjustable mirror mount, according to the present invention. The laser 20 includes an elongated plasma tube 21 having a relatively larger diameter main body envelope portion 22 and a relatively smaller diameter anode envelope portion 23. An elongated capillary hollow discharge tube 24 is supported by the anode envelope 23. The plasma tube 21 contains an active laser gas or mixture such as He-Ne, for example. The gas is allowed to circulate within the plasma tube 21, the capillary tube 24, and through an aperture in the capillary tube 24 at the other end (not shown) of the tube 24.

The anode envelope 23 is attached to one end of an elongated member, shown here as a metal cylindrical member 27, to which the mirror 29 is mounted. The other end of the cylinder 27 may be flared for mounting the mirror 27 thereto by means of a glass frit 28 or glass solder. The wall thickness of the mid-section of the member 27 is somewhat thinner than the rest of the cylinder. This is so that the member 27 can be easily deflected along its axis for adjusting the mirror 29. The mirror 29 consists of a cylindrical glass substrate 30 having a quarter-wave filter 31, or other suitable filter deposited on one face. A quarter-wave filter 31 may be a series of coatings deposited on the glass substrate which selectively reflects the particular wavelength of the subject lasing gas. In order to seal the mirror 29 to the cylinder 27, the complete assembly, including a Brewster window (not shown) mounted within the cylinder 27, is placed into a 450°C oven where the glass frit melts and seals the mirror 29 to the flared end of the cylinder 27.

An outer member or collar shown here as a cylinder 33 is disposed about the inner cylindrical member 27 and attached thereto by a flanged end 34. The collar 33 may

1 be made of any suitable material which is sufficiently  
rigid so as not to be easily deflected. Materials such as  
aluminum, steel or even hard plastic may be used. The  
collar 33 may be attached to the inner cylindrical member  
5 27 by welding, soldering, brazing or using an adhesive  
such as epoxy, for example.

The collar 33 has a plurality of adjustment screws  
36a-36d, radially disposed about its circumference.  
Adjustment screws 36a and 36b are shown, while screws 36c  
10 and 36d are not shown but are perpendicular to the first  
two screws. In order to adjust the mirror 29 at the end  
of the inner cylinder 27, the screws are alternately  
tightened or loosened so as to deflect the inner cylinder  
27 within its elastic limit. The outer member 33 serves  
15 several purposes; it adjusts the mirror and it also  
protects it from being accidentally disturbed if bumped.  
The collar 33 may also extend beyond the mirror 29 in  
order to provide greater protection. Another advantage  
of the present invention is that the elastic limit of the  
20 inner cylinder is not exceeded and thus the laser is  
easier to tune or adjust.

Although the invention has been shown and described  
with respect to particular embodiments, nevertheless,  
certain changes and modifications made by one skilled in  
25 the art to which the invention pertains are deemed within  
the purview of the invention.



Claims:

- 1           1. An adjustable mirror mount for a laser,  
          comprising:  
              a cylindrical member attachable to a laser  
          discharge tube for mounting a reflector to one end there-  
5           of; and  
              adjustment means disposed about the reflector end  
          of said cylindrical member for deflecting said cylindrical  
          member and thereby adjusting the position of said reflector.
- 1           2. The invention according to Claim 1 wherein said  
          cylindrical member, comprises:  
              a cylinder having a selected thickness and a  
          portion of the circumference having a reduced thickness  
5           for permitting said tubular member to be deflected along  
          its axis.
- 1           3. The invention according to Claim 1 wherein said  
          adjustment means comprise:  
              an outer member mounted to said cylindrical  
          member and extending substantially the length of said  
5           cylindrical member; and  
              means extending from said outer member and  
          impinging upon said cylindrical member for deflecting said  
          cylindrical member along its axis.
- 1           4. The invention according to Claim 1 further  
          comprising:  
              a reflector mounted to the end of said  
          cylindrical member.

1           5. An adjustable mirror mount for a laser,  
comprising:

          a cylindrical member having first and second  
ends, said first end for mounting to a laser discharge  
5   tube, said second end for mounting a reflector thereto;  
          adjustment means radially disposed about and  
impinging upon said cylindrical member, said adjustment  
means for deflecting said reflector end of said cylindrical  
member thereby adjusting said reflector; and  
10           means for supporting said adjustment means  
mounted to said first end of said cylindrical member.

1           6. An adjustable mirror mount for a laser,  
comprising:

          a cylindrical member having first and second  
ends, said first end for mounting to a laser discharge  
5   tube, said second end for mounting a reflector;

          an outer member having first and second ends  
being longitudinally mounted to said cylindrical member  
at said first ends; and

          adjustment means mounted to the second end of  
10   said outer member for deflecting said cylindrical member  
and adjusting said reflector.

1           7. A laser having an adjustable mirror, comprising:  
          a laser discharge tube for containing a lasing  
medium;

          a first elongated member, having first and  
5   second ends, mounted to said laser discharge tube by said  
first end;

          a reflector mounted to said second end of said  
first elongated member;



10 a second elongated member mounted coaxially, by  
one of its two ends, to said first elongated member; and  
adjustment means rigidly mounted to the other  
end of said second elongated member for deflecting said  
first elongated member and adjusting said mirror thereby.

1 8. An adjustable mirror mount in accordance with  
Claim 6 wherein said adjustment means comprises:

a plurality of screws rotatably anchored in  
the second end of said second elongated member.

1 9. An adjustable mirror mount for a laser,  
comprising:

5 an elongated member directly attachable to and  
in fluid communication with a laser discharge tube for  
mounting a reflector to one end thereof;

an outer member having first and second ends,  
said first end being rigidly mounted to said elongated  
member, said outer member surrounding said elongated  
member; and

10 a plurality of radially disposed lever means  
extending through said outer member and impinging on said  
elongated member for deflecting said inner member thereby  
adjusting said reflector.



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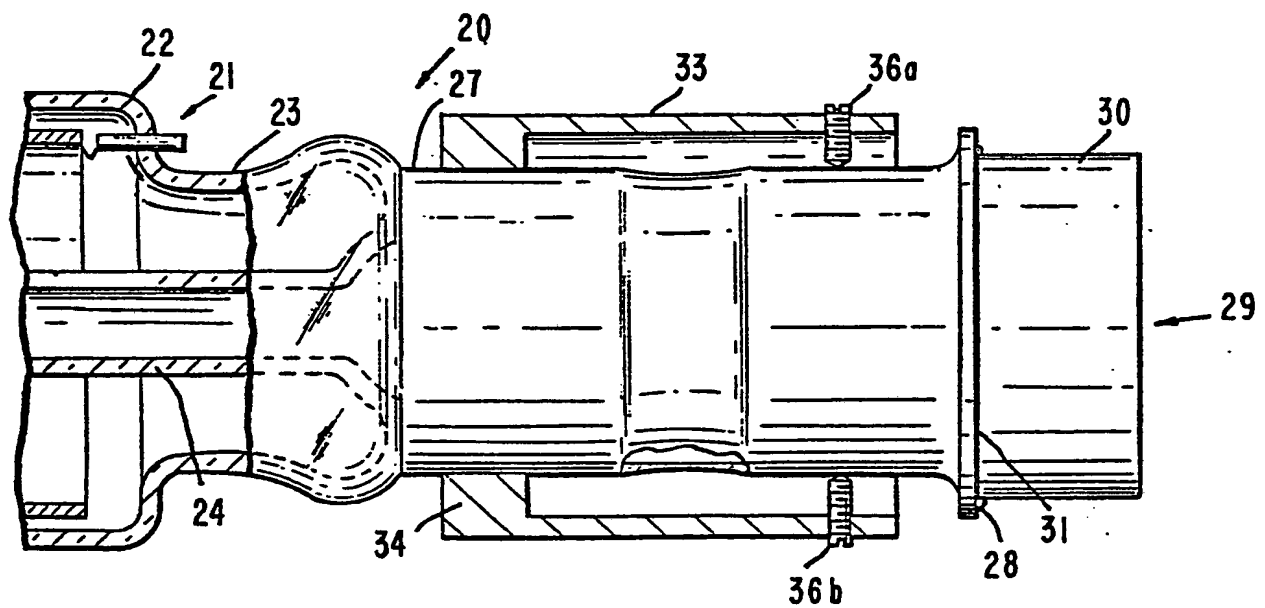


Fig. 1.

## INTERNATIONAL SEARCH REPORT

International Application No PCT/US79/00881

**I. CLASSIFICATION OF SUBJECT MATTER** (If several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC

INT CL. H01S 3/086

US CL. 331/94.5C

20/0123

**II. FIELDS SEARCHED**

## Minimum Documentation Searched \*

Classification System

Classification Symbols

US

331/94.5C, D; 350/288

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched \***III. DOCUMENTS CONSIDERED TO BE RELEVANT** <sup>14</sup>

Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>		Relevant to Claim No. <sup>18</sup>
X	US A 3,826,998	Published 30 July 1974, Kindl et al	1, 2, 4
X	US A 3,864,029	Published 04 February 1975 Mohler	1, 4, 5
X	US A 3,883,820	Published 13 May 1975, Burns et al	1, 2, 4, 5
X	US A 3,953,113	Published 27 April 1976, Shull	1, 2, 4

\* Special categories of cited documents: <sup>15</sup>

"A" document defining the general state of the art

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the invention

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**IV. CERTIFICATION**

Date of the Actual Completion of the International Search \*

12 DECEMBER 1979

Date of Mailing of this International Search Report \*

15 JAN 1980

International Searching Authority <sup>1</sup>

ISA/US

Signature of Authorized Officer <sup>20</sup>W. Sikes *William L. Sikes*